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**UNITED STATES DISTRICT COURT
CENTRAL DISTRICT OF CALIFORNIA-WESTERN DIVISION**

IN RE NJOY, INC.
CONSUMER CLASS
ACTION LITIGATION

) Case No. CV 14-00428-MMM-JEMx
) **CLASS ACTION**

)
) **SUPPLEMENTAL DECLARATION**
) **OF JEFFREY E. HARRIS IN**
) **SUPPORT OF PLAINTIFFS'**
) **MOTION FOR CLASS**
) **CERTIFICATION**

) Judge: Margaret M. Morrow

) Mag. Judge: John E. McDermott

) Room: 780 Roybal

) Date: December 14, 2015

) Time: 10:00 a.m.

**UNITED STATES DISTRICT COURT
CENTRAL DISTRICT OF CALIFORNIA-WESTERN DIVISION**

IN RE NJOY, INC. CONSUMER
CLASS ACTION LITIGATION

Case No. CV 14-00428-MMM (RZx)

**SUPPLEMENTAL DECLARATION OF JEFFREY E. HARRIS
IN SUPPORT OF PLAINTIFFS' MOTION FOR CLASS CERTIFICATION**

September 23, 2015

Introduction

1. I submitted an expert declaration on May 15, 2015 [1] in connection with Plaintiffs' motion for class certification in the above-captioned matter. (Numbers in brackets refer to endnotes.) I gave deposition testimony on June 3, 2015 [2] and submitted a reply declaration on July 1, 2015 [3]. This supplemental declaration responds to this Court's Order Denying Plaintiffs' Motion for Class Certification, dated August 14, 2015 [4]. In particular, I respond to this Court's conclusion that my proposed damage analyses do not satisfy the requirements articulated by the U.S. Supreme Court in *Comcast Corp. v. Behrend* [5].

Summary

2. In this declaration, I correct the specific deficiencies in both the conjoint analysis and direct method that this Court identified in its recent order. (See "(d) Whether Damages Can be Proved on a Classwide Basis" in [4] at 84–90.)

3. In further response to the Court's recent order, I propose an additional damage model that addresses the limitations of hedonic regression analysis of the market prices of electronic cigarettes. To that end, the damage model combines the hedonic analysis of market prices with additional relevant sources of information, including the results of conjoint analysis.

I. I address the deficiencies in the conjoint analysis and direct method identified by this Court.

A. The application of conjoint analysis in the present case will accommodate all of the features of the conjoint analysis described by plaintiffs' expert in *Guido v. L'Oreal*.

4. In its recent order, this Court noted ([4] at 89):

The conjoint analysis in *Guido*, moreover, considered many more factors than Harris proposes to do here. First, the *Guido* expert stated that his conjoint analysis would take market factors into account in isolating part worth, e.g., different brands of hair serums. Harris does not employ a similar methodology. The *Guido* expert proposed to use the data captured to construct a regression model that captured the part worth of the feature at issue. He also proposed to account for "[a]ll other factors influencing value" by employing a stochastic component that could ultimately be integrated out of the overall price function; when this was done, he asserted, one was left with the price premium attributable to the alleged

misrepresentation. Harris's declaration states only that he will isolate a consumer's subjective willingness to pay for a product in the absence of misleading omissions or misrepresentations. He proposes to do this by asking respondents a series of questions concerning their subjective valuation of products with and without the alleged misrepresentations and omissions. Unlike the expert's in *Guido*, therefore, his method is entirely subjective and lacks any market-based component. The court therefore finds the case unpersuasive. [Footnote citations omitted.]

5. My application of conjoint analysis to the present case will accommodate all of the features of the conjoint analysis described by Dr. Sanjog Misra in his expert report in *Guido v. L'Oreal* [6] and remedy all of the deficiencies identified above by this Court.

6. In particular, the choice sets offered to participants in the conjoint survey will include different brands of electronic cigarettes. One of the attributes of these brands will be their actual market price. Accordingly, my conjoint analysis will have a "market-based component." As an example, the following simplified choice set is a modified version of the choice set shown in my reply declaration ([3] at ¶20). The left-hand product profile shows the current market price of 5 disposable *NJOY Kings* [7], while the center profile shows the current market price of 5 disposable *Puf* electronic cigarettes [8].

Which one of these products are you most likely to buy?

<p>e-Cigarette</p>  <p>\$29.95 for a pack of 5 disposable e-cigarettes</p> <p>Safer than tobacco cigarettes</p> <p>Battery life 250 puffs</p>	<p>e-Cigarette</p>  <p>\$44.95 for a pack of 5 disposable e-cigarettes</p> <p>No safer than tobacco cigarettes</p> <p>Battery life 450 puffs</p>	<p>Neither of these two products</p>
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7. Moreover, the regression model that I will employ to analyze participants' choices will include a stochastic component to account for "all other factors influencing value," as described in ¶22(vii) of Dr. Misra's report [6]. My statistical method will integrate out all other observed factors as well as the unobserved stochastic component in

order to derive a price premium attributable to the alleged misrepresentation, as described in ¶22(vii)–(x) of Dr. Misra’s report [6].

B. Both conjoint analysis and the direct method will be applied to market prices in the present case in a manner consistent with the trial court’s analysis in Saavedra v. Eli Lilly.

8. In its recent ruling, this Court referred specifically to the case of *Saavedra v. Eli Lilly* [9]. This Court noted, in particular ([4] at 87):

In their opposition, plaintiffs attempt to distinguish *Saavedra*, asserting that it is a “benefit-of-the-bargain” case. They contend their damages theory is restitutionary in nature, and hence the case is distinguishable. The court finds this argument unpersuasive, as the theory of liability and damages methodology in *Saavedra* were both remarkably similar to those at issue here.

9. In *Saavedra*, Plaintiffs’ economics expert Dr. Joel W. Hay proposed using conjoint analysis to compute the “refund ratio” that consumers of a particular pharmaceutical product would require if they learned that the product had a much higher risk of withdrawal symptoms than the manufacturer allegedly disclosed. In its decision on class certification, the *Saavedra* trial court opined ([9] at 16):

Therefore, applying Dr. Hay’s refund ratio to the price paid by consumers in such a market would yield a valid approximation of the value lost due to the misrepresentation. Although the refund ratio determined via conjoint analysis still looks only to the demand side of the equation, *applying this ratio to the market price at least tethers it to a functioning market and thus to the product’s fair market value.* (Emphasis added.)

10. The *Saavedra* trial court ultimately denied class certification not because Dr. Hay had proposed to use conjoint analysis, but because consumers’ out-of-pocket costs, net of insurance coverage, had little or no relation to the drug’s value ([9] at 16–17).

11. In my application of both conjoint analysis and the direct method in the present case, I will incorporate market prices directly into the surveys so as to “tether” the results “to a functioning market and thus to the product’s fair market value.”

12. In my application of conjoint analysis, as noted in ¶6 above, the choice sets offered to participants in the survey will include different brands of electronic cigarettes. One of the attributes of these brands will be their market price.

13. In the description of the direct method in my initial expert declaration ([1] at ¶¶59–61), I provided a series of questions designed to elicit the percentage discount required to induce each survey respondent to purchase an electronic cigarette that had not been shown to be safe or safer than conventional tobacco cigarettes. In my application of the direct method, I will incorporate market prices directly into these questions.

14. Thus, respondents would first receive the following modified instruction: “Suppose you had a choice between two different kinds of e-cigarettes. Each of the two e-cigarettes tastes exactly the same. Each costs \$29.95 for a five-pack of disposable king-size e-cigarettes, that is, \$5.99 for a single disposable e-cigarette. They are, in fact, identical in every way to the e-cigarettes you use, except that these two products differ in their safety profiles.” This modified instruction follows the text of ¶59 of my original declaration [1], but makes specific reference to the current market price of NJOY King.

15. Moreover, all respondents who would prefer the e-cigarette with the Defendant’s safety claim at the same price would then be asked a series of modified questions to ascertain their willingness to pay for the product without the safety claim: “Now suppose instead that you could purchase the second e-cigarette at a price of \$26.95 for a five-pack of king-size e-cigarettes. The first e-cigarette still costs \$29.95 for a five-pack. Which e-cigarette would you buy?” This modified question still reflects a 10-percent discount off the original price of \$29.95, but refers specifically to the market price. In a modification of ¶60 of my original declaration [1], the same question would then be repeatedly posed in terms of a series of decreasing market prices, with each price decrement equivalent to 10 percentage points, until the price discount was sufficiently large to induce the respondent to purchase the second e-cigarette.

16. In a modification of ¶61 of my original declaration [1], the average price premium attributable to Defendant’s safety claim, measured in dollars per unit sold, would then be computed separately for the California and Florida classes. For each class, respectively, class-wide damages would equal the product of the price premium and the total number of units sold in the class period.

17. In its recent order ([6] at 11–12), this Court took judicial notice of the *Amicus Curiae* brief filed by Nobel Prize-winning economists Robert Solow and George Akerlof in support of plaintiffs-appellees in *Price v. Philip Morris* [10]. In that case, I testified as

an expert witness on behalf of plaintiffs in a class action suit alleging fraudulent misrepresentations in the marketing of “light” cigarettes. In that capacity, I performed a damage analysis utilizing the direct method.

18. In their *Amicus Curiae* brief, Nobelists Solow and Akerlof note ([10] at 3–4):

It is *Amici*’s understanding that the applicable legal standard for determining damages under the Illinois Consumer Fraud Act and for purposes of this case is defined as follows: “Damages are determined by assessing the difference between the actual value of the property sold and the value the property would have had if the representations had been true.” [Citations omitted.] *This is precisely the measure of damages utilized by plaintiffs’ expert Dr. Harris in this case and accepted by the trial court in its Order. In addition, this measure of damages coincides with generally accepted principles of economics.* (Emphasis added.)

...

In order to measure the damages resulting from Philip Morris’ misrepresentations, Dr. Harris utilized a questionnaire survey to estimate the fraction of the purchase price that members of representative sample of buyers assign to the attributes promised through the misrepresentation at issue. Although there may be more than one way to measure damages under the facts and circumstances of this case, and although some statistical uncertainty always attaches to sample survey results, as it does in clinical trials, *there should be no dispute that the methodology applied by Dr. Harris was theoretically sound and methodologically consistent with generally accepted economic principles.* (Emphasis added)

19. In short, both conjoint analysis and the direct method have the capability of quantitatively isolating the price premium attributable to Defendant NJOY’s safety claim. These methods are not merely subjective or speculative, but can be directly pegged to real-world market prices.

II. I propose an additional damage model that addresses the limitations of hedonic analysis of the market prices of electronic cigarettes.

A. Hedonic regression analysis of the market prices of electronic cigarettes may suffer from important limitations.

20. Hedonic regression analysis employs data on the prices of different brands or models of a product in order to decompose the price of the product into separate components attributable to specific product characteristics ([3] at ¶30). Once a database of prices and attributes has been assembled, the analyst employs a multivariate regression

program that is widely available in statistical packages to compute the components of price attributable to each characteristic.

21. In the context of the market for electronic cigarettes, hedonic regression analysis may suffer from important limitations ([3] at ¶¶30–33).

22. One potential limitation is the presence of *collinearity* in the data employed in the regression analysis. Collinearity arises when there is not enough independent variability in the data to separate out the price components attributable to two or more product characteristics ([3] at ¶30). In the context of sport utility vehicles, which I used as an example in my initial declaration ([1] at ¶¶45–47), hedonic regression analysis might employ data on the market prices of different models of SUV with varying characteristics (with or without a sunroof, fabric or leather seating, manual or automatic transmission, custom or stock body color) in order to isolate statistically the price component attributable to the presence of a sunroof. However, if every SUV model with a sunroof also had four doors, and if every SUV model with four doors also had a sunroof, a hedonic regression analysis would be unable to attribute a separate price component to the presence of a sunroof alone. That is, the two attributes – a sunroof and four doors – would be *collinear*.

23. In *In Re Conagra Foods, Inc.*, plaintiffs alleged that defendant deceptively marketed its Wesson cooking oil as “100% Natural,” whereas the product was in fact made from genetically modified organisms (“GMOs”). Plaintiffs’ expert Dr. Colin Weir initially proposed a hedonic regression analysis to estimate the component of price that was separately attributable to defendant’s “100% Natural” claim [11]. The court observed that consumers might construe the “100% Natural” claim to be broader than a claim that the product was free of GMOs and, accordingly, that the price component attributable to the former might exceed that attributable to the latter [12]. That is, hedonic regression analysis might be unable to separately isolate the price component of the implied GMO-free claim because it was collinear with the broader “100% Natural” claim.

24. One potentially important attribute of a product is its brand name. The brand name may capture unique aspects that consumers associate with the product quite apart from its specific characteristics. In the laser printer market, for example, consumers may perceive the brand name “HP” as connoting quality, reliability or other aspects of brand

equity quite apart from any specific model's printing speed, resolution, color capability or paper handling [13]. If a branded product has a unique attribute, hedonic regression analysis may be unable to separate out the components attributable to the brand name and the specific attribute. In *Werdebaugh v. Blue Diamond Growers*, the court criticized an alternative hedonic regression analysis proposed by plaintiff's expert Dr. Oral Capps for not distinguishing between the Blue Diamond brand name and the presence of the claims "All Natural" and "Evaporated Cane Juice" in the product labeling. That is, the product's brand name and the allegedly misleading product labeling were collinear ([14] at 11).

25. Attempts to work around the problem of collinearity in hedonic regression analysis have generated their own paradoxes. In *Brazil v. Dole Packaged Foods* [15], both the defendant Dole and one competitor Del Monte allegedly made "All Natural" claims. In his principal hedonic regression model, plaintiff's expert Dr. Capps avoided the problem of collinearity between brand and claim by including a brand-specific variable only for Dole but not for Del Monte. (See "b. Alleged Flaw #2: The Model Confuses "Brand" and "Label" in [15] at 14–16.) This apparently innocent econometric restriction, however, had the effect of discarding the data on Dole brands from the estimation of the value of the "All Natural" claim. As a result, the price component attributable to the "All Natural" claim was derived from a comparison between Del Monte and other brands.*

26. In the electronic cigarette market, as I noted in my reply declaration, a hedonic regression analysis may be unable to reliably separate NJOY's safety claims from any other unique characteristics associated with the NJOY brand ([3] at ¶33). Such unique characteristics, Defendant's expert Dr. Scott has suggested, include "the look and feel of a regular tobacco cigarette." ([16] at ¶62). That is, there may be collinearity between the NJOY brand name and the defendant's safety claim. Likewise, a hedonic

* The following simple example with only 3 brands and 2 variables makes the point:

<i>Brand</i>	<i>Dole Brand Variable</i>	<i>Claim Variable</i>	<i>Product Price</i>
Dole	1	1	\$100
Del Monte	0	1	\$5
Other	0	0	\$1

The *Dole Brand* variable is equal to 1 only for the Dole product, while the *Claim* variable is equal to 1 for both Dole and Del Monte products. The component of price attributable to the *Claim* variable is \$5 – \$1 = \$4, and this conclusion is independent of the price of the Dole product.

regression analysis comparing the prices of NJOY with those of conventional tobacco cigarettes may fail to isolate the price component attributable to NJOY's safety claim since the safety claim may be collinear with "the lack of social stigma associated with traditional cigarettes, or a number of other benefits and features that consumers get with an electronic cigarette and not a regular tobacco one." ([3] at ¶33, quoting Dr. Scott).

27. Table 1 below shows selected data on NJOY cigarettes and competitor e-cigarettes. This amalgam of contemporaneous data on brand characteristics, derived from product websites, and historical data on advertising expenditures, derived from NJOY internal documents, is intended to be illustrative rather than representative of the larger market during the class period.

Table 1. Characteristics of NJOY and Competitor Brands

Brand	Current Price of 5 Cartridges ^a	Maximum Nicotine (mg) ^b	Number of Puffs ^c	Advertising Spending 2012 (\$000) ^d
<i>NJOY</i> [7]	13.99	45	REDACTED	
<i>Blu</i> [17]	12.80	24	250	
<i>Crown7</i> [18]	12.95	18	300	REDACTED
<i>Green Smoke</i> [19]	12.99	24	400	
<i>Logic</i> [20]	22.99	24	400	
<i>Metro</i> [21] ^e	16.65	18	300	REDACTED
<i>Starfire</i> [22]	9.99	24		
<i>V2 EX</i> [23] ^f	14.95	24	400	
<i>V2 Classic</i> [23] ^f	9.95	24	150-200	

Notes to Table 1:

- a. Derived from product websites accessed on 14-Sep-2015 [7, 17-23].
- b. Maximum nicotine delivery, as reported on product websites. Minimum delivery is generally 0 mg.
- c. Average number of puffs per cartridge, as reported on product websites. No specific data on the number of puffs are disclosed on the *NJOY* and *Starfire* websites [7, 22]. REDACTED
- d. REDACTED
- e. Price of 3-pack of Metro cartridges is \$9.99. Calculated value for price of 5 cartridges is $(5/3) \times \$9.99 = \16.65 .
- f. *V2 EX* cartridges are advertised as having an increased puff count compared to *V2 Classic* cartridges.

28. Advertising may raise consumers' brand awareness and influence their perceptions of the unique aspects of a brand. In *Werdebaugh*, the court initially accepted the hedonic regression analysis of plaintiff's expert Dr. Capps on the assumption that advertising expenditures would be one of the variables in the analysis ([14] at 4). I understand that data on NJOY's and competitors' advertising expenditures during the entire class period are available for purchase from Nielsen, and that such data would be available in a complete hedonic regression analysis [27, 28]. While I do not currently have access to complete advertising data, the substantial variation in expenditures during 2012 alone suggests that this variable may help to explain price differences among brands. The problem is that NJOY's advertising expenditures were intended in great part, if not exclusively, to transmit its alleged safety claims. As a result of this potential confounding between advertising expenditures and NJOY's safety claims, the inclusion of advertising expenditures in the hedonic regression model could result in an underestimate of the price premium attributable to the safety claim.

29. A second potential limitation of hedonic regression analysis is the presence of *omitted variable bias*. The problem is not simply that a hedonic regression analysis fails to take a particular product attribute into account, but that the omitted attribute is correlated with the observed attribute that is the focus of the analysis. For example, in the study of real estate markets, some hedonic analyses have found that house prices are paradoxically positively associated with higher levels of air pollution. One proposed explanation is that areas with high air pollution are more urbanized and may have higher per capita income, which in turn drives up real estate prices. That is, per capita income is the omitted variable that is correlated with the level of air pollution [29].

30. A hedonic regression analysis of the electronic cigarette market may suffer from comparable problems of omitted variable bias. The illustrative data in Table 1 suggest that the number of puffs may be an important determinant of price, as the *EX* version of V2 cartridge, which supposedly delivers 400 puffs, is priced higher than the *Classic* version, which supposedly delivers 150–200 puffs. On the other hand, there is no obvious relation between product price and the range of purported nicotine deliveries. But these purported product characteristics may not capture other important variables that are not revealed in manufacturers' product claims, including REDACTED

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These omitted variables may explain why some brands, such as *Logic*, have commanded a higher market price than NJOY.

31. In *Werdebaugh v. Blue Diamond Growers*, the court looked favorably on a proposed hedonic analysis that would compare the prices of defendant Blue Diamond's almond milk before and after the introduction of "All Natural" and "Evaporated Cane Juice" in the product labeling [14, 31]. Such a before-after approach, however, may fail to account for some other variable that influenced price and was changing at the same time that the labeling was introduced. Such omitted variables might include changing prices of substitutes like cow's milk and soymilk, the growing popularity of almond milk as a milk alternative, and increasing drought conditions that could raise the price of almonds, whose trees require more water-intensive cultivation.

32. The before-after approach would suffer from the same limitations in a hedonic regression analysis of the electronic cigarette market. In her declaration in the present litigation, Defendant's expert Dr. Scott noted, "my observation of NJOY wholesale prices of NJOY electronic cigarettes shows that prices did not change after the company changed its package label to include more information on its ingredients." ([16] at ¶¶62, 82). During the time periods surrounding NJOY's changes in its advertising and product packaging, other competitors may have also changed their advertising content and product labeling. While Dr. Scott offers no specifics, it appears that the cited change in package label and the associated lack of change in retail price occurred while the present litigation was in progress. Accordingly, one important omitted factor would be the extent to which NJOY's pricing strategy was influenced by ongoing litigation risks.

33. A third potential limitation of hedonic regression analysis is the problem of *misclassification*. As I noted in my rebuttal disclosure, a hedonic regression analysis designed to estimate the price component of an SUV attributable to presence of a sunroof can run into problems when some sunroofs can be opened from the dashboard, while others have tinted glass ([3] at ¶31). Misclassifying these heterogeneous product

attributes as if they belonged to a single homogeneous category of “sunroof” can result in inaccurate if not meaningless conclusions.

34. In *Werdebaugh v. Blue Diamond Growers*, plaintiff’s expert Dr. Capps was criticized for misclassifying some competitors’ products as not having “All Natural” claims ([14] at 6–7). But the more serious problem was that not every “All Natural” claim was necessarily identical. Whole Foods’ almond milk, for example, was labeled as “Organic.” ([31] at 19). Other claims may have also referred to “natural flavors” or “no hormones,” while others noted that their milk was “plant based.”

35. The electronic cigarette market presents the same potential problem of misclassifying a heterogeneous collection of product claims as if they belonged to a single homogeneous category of “safety claim” ([3] at ¶33). A *Blu* advertisement noted, “*blu* produces no smoke and no ash, only vapor, making it the smarter alternative to regular cigarettes.” [32]. One *V2* advertisement noted, “Upgrade your health today!” [33], while another *V2* advertisement noted, “Smoke Free. Odor Free. Guilt Free.” [34]. A 2014 *Puf Cigs* advertisement noted, “Kick the habit today with the best e-cigarette on the market.” The associated post on Facebook added, “Visit Puf Cigs today and order your electronic cigarette starter kit today and start living a healthier and prettier life.” [35]. Another 2014 *Puf Cigs* advertisement noted, “Break the habit TODAY! Order the best e-cigarette on the market and take the first steps to a healthier you.” The associated Facebook post added, “Are you a smoker and want to break the habit? Electronic cigarettes are the way to go.” [36].

36. Similar problems of potential misclassification arise in the analysis of product warnings. The current website of *Crown7* notes, in part, “The vapor is primarily propylene glycol, water, nicotine and flavor. Electric cigarettes contain nicotine which is highly addictive. Therefore, the Crown7 electric cigarette is not recommended to be used by non smokers.” [18] The website has a link to a downloadable manual that states, “CROWN7 has never been proven to be a smoking cessation device and is not sold or marketed as such.” [37] By contrast, the current website of *Vapor Kings* states, in part, “Most cartridges and e-Liquids contain primarily a mixture of water, propylene glycol, a flavoring agent of some type and depending on the cartridge strength, a certain amount of nicotine. While all of these ingredients alone are deemed as safe by the FDA they have

not been FDA tested in the cartridge/e-liquid form. There is much controversy currently concerning this matter. It is up to you to decide if you have any type of reaction to these ingredients.” The website adds, “Our products are not intended to diagnose, treat, cure or prevent any disease or addiction.” It could be problematic classifying both of these products as simply having “no safety claim.” [38]

37. These potential problems of classical hedonic regression analysis – collinearity, omitted variable bias, and misclassification – can be adequately addressed if the analyst is permitted to rely upon additional information that is, strictly speaking, outside the original market database. Survey data, in particular, can supply the missing information on consumers’ perceptions of the unique characteristics of different brands of electronic cigarettes. Survey data can help the analyst appreciate whether one brand has a greater “nicotine hit” in the first few puffs. Consumer survey data can help the analyst determine whether the “smarter alternative” or “guilt free” or “break the habit” should be classified as safety-related claims.

B. Bayesian hedonic regression analysis can address the limitations of classical hedonic regression analysis of the electronic cigarette market.

38. In *In re ConAgra Foods, Inc.*, this Court concluded that a hedonic regression analysis designed to estimate the price component attributable to a “100% Natural” claim was insufficiently narrowly tailored to plaintiff’s theory of liability based upon the presence of GMOs. That is, the hedonic regression analysis proposed by plaintiff’s expert Dr. Colin B. Weir could not isolate the price component attributable to the implied GMO-free claim because it was collinear with the broader “100% Natural” claim. (See ¶23, *supra*.) To resolve this problem of collinearity, this Court approved a “hybrid damages methodology” in which Dr. Weir’s hedonic analysis was supplemented by a separate conjoint analysis proposed by plaintiff’s expert Dr. Elizabeth Howlett ([12] at 69).

39. As I explain in greater detail in the Appendix, the hybrid model approved by this Court in *ConAgra* constitutes one example of a larger category of statistical models in which classical regression analysis is supplemented by sources of information outside the narrow regression database. These *Bayesian* statistical models have been extensively developed and widely applied over the past four decades [39]. In an early contribution to this literature, Dr. William DuMouchel and I used the results of carcinogenicity and

mutagenicity tests in laboratory animals to supplement epidemiological database on human lung cancer risks of diesel fumes, coal tar, and cigarette smoke [40]. Bayesian regression modules are available in a number of statistical software packages, including Stata [41].

40. Bayesian statistical models have been applied worldwide to hedonic regression analysis, particularly in the study of real estate prices [42-48], but also in the study of the prices of consumer products, such as laser printers [13]. In Bayesian terminology, the sources of supplemental information are called *priors*. In his review of Bayesian hedonic regression, van Auer cites a 1987 contribution by Atkinson and Crocker [47], noting, “They find that using Bayesian priors can alleviate collinearity problems that are prevalent in property value studies.” ([13] at 1352–1353).

41. In Bayesian statistical models, the sources of supplemental information need not be confined to consumer surveys. Wheeler and colleagues, in a Bayesian hedonic regression analysis of house sale prices in Toronto, noted that their model “may be specified to include expert market opinions.” ([42] at 663, 677–680). In the present context, they may also include information from Defendant NJOY’s internal documents.

42. As I note above, classical hedonic regression analysis may be incapable of distinguishing between a “brand effect” and a “claim effect” on product price. (See ¶¶24–26, *supra*.) In the present context, market-based comparative data of the type illustrated in Table 1 may be insufficient to determine whether a price differential observed for NJOY can be attributed to its “look, feel and flavor of the real thing” or its assurance that “you keep the good things you like about smoking, while losing the things you don’t.” (See the advertisement entitle “Start a New Relationship” in [49] at 36.) In a conjoint analysis (or in a direct consumer survey), however, the analyst can ask e-cigarette smokers to value these characteristics independently, without explicit reference to the NJOY brand name. The relative valuations derived the conjoint analysis then become priors in a Bayesian hedonic regression.

43. Similarly, as I note above, ordinary hedonic regression analysis may be unable to account for important omitted variables, such as the REDACTED

REDACTED [30] REDACTED, a new supplemental survey can be performed to evaluate these omitted variables. The survey results then become priors that are incorporated into the Bayesian regression analysis.

44. Finally, as noted above, an ordinary hedonic regression analysis cannot resolve potential problems of misclassification of advertisements and warnings issued by competitor brands. (See ¶¶35–36, *supra*.) A conjoint survey, however, could assess consumers’ comparative valuations of such phrases as “smarter alternative to regular cigarettes,” “guilt free,” and “the first steps to a healthier you.” The valuations derived from such a conjoint survey would likewise become priors to be incorporated into a Bayesian analysis.

45. In the two-step hybrid damage model accepted by this Court in *ConAgra*, the hedonic regression analysis was to be carried out as a first step. If that analysis revealed a price premium attributable to defendant’s “All Natural” claim, then a conjoint analysis was to be conducted as a second step. The relative partworths of a “GMO Free” claim and an “All Natural” claim, as derived from the second-step conjoint analysis, were then to be used to refine the price premium derived from the first-step hedonic regression.

46. A more general Bayesian hedonic regression analysis, however, does not necessary follow *ConAgra*’s two-step sequence. Thus, to distinguish “brand” and “claim” effects, the analyst may first conduct a conjoint analysis to determine the relative partworths of the “look, feel and flavor of the real thing” versus the assurance that “you keep the good things you like about smoking, while losing the things you don’t.” The results of the conjoint analysis then serve as an input into the hedonic model. Similarly, to address omitted variables, the analyst may first conduct a conjoint analysis or direct survey to assess REDACTED

REDACTED. These survey results would then serve as an input into the hedonic model. Finally, to avoid misclassification of other brands’ advertising and warnings, a conjoint analysis may first assess the relative partworths of such phrases as “smarter alternative to regular cigarettes,” “guilt free,” and “the first steps to a healthier you.” These partworths would then serve as inputs to the Bayesian hedonic regression model.

47. In short, Bayesian statistical analysis is a widely accepted method for incorporating additional sources of information into a classical regression model. Bayesian hedonic regression analysis is an established technique for incorporating additional sources of information into a classical hedonic regression analysis. The “hybrid damage methodology” approved by this Court in *ConAgra* constitutes an example of Bayesian hedonic regression analysis. Bayesian methods of incorporating additional information can likewise be applied to the hedonic analysis of market prices in the present e-cigarette litigation. The incorporation of such additional information, which can be derived from newly performed conjoint or direct surveys or from the results

REDACTED can resolve a number of significant potential problems that would arise from the application of classical hedonic regression alone. Bayesian hedonic regression can reliably isolate the price premium attributable to Defendant’s safety claim.



Jeffrey E. Harris, September 23, 2015

Appendix. Bayesian hedonic regression analysis and the *ConAgra* hybrid

48. In this appendix, I explain in more technical detail why the “hybrid damages model” approved by this Court in *ConAgra* [12] is a particular example of the application of Bayesian analysis to the hedonic regression model.

49. Let p denote an $N \times 1$ vector of observed product prices, let X denote an $N \times M$ matrix of observed product attributes, and let β denote an unknown $M \times 1$ parameter vector. I assume that p is normally distributed with mean $X\beta$ and $N \times N$ variance-covariance matrix $\sigma^2 I$, where σ^2 is unknown scalar parameter and I is the $N \times N$ identity matrix. I summarize these assumptions by the notation $p \sim N(X\beta, \sigma^2 I)$.

50. In classical hedonic regression analysis, the unknown parameter β can be estimated by ordinary least squares, while the unknown parameter σ^2 can be computed from the root mean squared residuals. A critical assumption underlying the classical approach is that the observation matrix X has full rank, that is, $\text{rank}(X) = M < N$. If two or more attributes are collinear, however, then the full rank assumption is not satisfied and the parameters β and σ^2 cannot be estimated.

51. In Bayesian hedonic regression analysis, by contrast, the full rank condition on the observation matrix X is not required. Instead, the analyst assumes that the parameter vector β has a prior distribution. Following an extensive line of studies dating back to a 1972 article by Lindley and Smith [39], Bayesian analyses generally assume that $\beta \sim N(b, V)$, where b and V are called *hyperparameters*. To complete the model specification, prior distributions are also specified for σ^2 , b and V . The parameters of these Bayesian regression model can then be estimated by Markov Chain Monte Carlo (MCMC) methods [50] that are available in a number of statistical packages.

52. In *ConAgra*, plaintiffs alleged that Wesson brand cooking oils were deceptively labeled as “All Natural,” when in fact they were made from genetically modified organisms (GMOs). ([51] at 3). Plaintiffs’ expert proposed a classical hedonic regression model in which the “All Natural” claim was to be one of the product attributes. In the present notation, the elements in one of the columns of X would equal 1 if the

product made the “All Natural” claim and 0 otherwise. The corresponding element of the parameter vector β would correspond to the component of price attributable to the claim.

53. In a critique of this initially proposed hedonic regression analysis, the court distinguished between the “All Natural” claim and a narrower “GMO Free” claim, maintaining that plaintiffs were required to assess the price premium attributable solely to the latter. This requirement posed a problem for plaintiffs’ hedonic regression analysis, as there were no available market data on cooking oils with only a “GMO Free” claim. In the present notation, the matrix X had two columns, one for “All Natural” and another for “GMO Free,” but the two columns always had the same value. That is, the two attributes were collinear and the full rank condition on X was thus violated.

54. Plaintiffs’ proposed solution, which the court subsequently accepted, was to supplement the hedonic regression model with additional information derived from a separate conjoint analysis. The court described this approach as a “hybrid damages model.” ([12] at 65). In the present notation, let the “All Natural” and “GMO Free” attributes correspond, respectively, to the first and second columns of X . Plaintiffs’ expert proposed: (1) to derive an estimate $\hat{\beta}_1$ from the initial restricted hedonic model, dropping the second column from the matrix X , and then (2) to compute $\hat{\beta}_2 = \hat{\theta} \hat{\beta}_1$, where the estimated parameter $\hat{\theta}$ was separately derived from the conjoint analysis. In particular, the estimate $\hat{\theta}$ would be computed as the ratio of the partworths for “GMO Free” and “All Natural” claims.

55. In the present Bayesian context, plaintiffs’ hybrid solution amounts to imposing the linear equality restriction $rb = 0$ on the prior distribution of the hyperparameters b , where $r = (\theta, -1, 0, \dots, 0)$ and where the corresponding prior distribution on θ was to be derived from the results of the conjoint analysis. This Bayesian approach has the advantage that all sources of uncertainty will be incorporated in the final posterior distribution of β_2 . More generally, all of the partworths derived from the conjoint analysis could inform the hyperparameters b and V . Such an approach would naturally take advantage of the fact that the Bayesian software commonly used to analyze conjoint survey data provides posterior distributions for the partworths [52].

End Notes

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